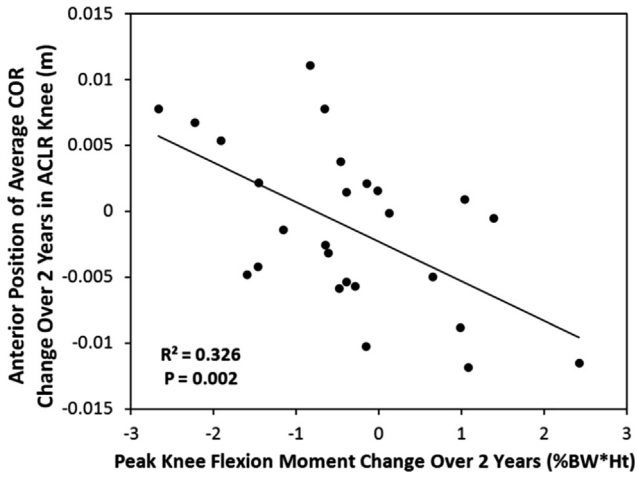

Figure 2. Correlation between changes in the anterior-posterior position of knee COR and changes in peak KFM from the nominal 2 year test to the 4 year follow-up. An anterior shift in COR over time is reported as a positive change in COR. Similarly, an increased KFM over time is reported as a positive change in KFM.

Conclusions: The differences in the knee COR between the ACLR and contralateral knee found in this study at the nominal 2 and 4 year follow-up provide new insight into the nature of the kinematic changes that are associated with ACLR. The greater lateral COR in knees at the 2 year follow-up suggest that there is greater motion on the medial plateau due to pivoting about a more lateral COR and could help explain the incidence of medial OA in this population. Additionally, the longitudinal change from the nominal 2 to the 4 year follow-up in the ML position of the COR suggests that the knee may be moving towards bilateral symmetry over time in many subjects. One of the most striking findings of this study was in the post-hoc analysis that identified the potential influence of the quadriceps muscles on kinematics. The relationship between the change in the AP position of the COR and change in peak KFM suggests that changing quadriceps contraction over time past surgery will change the AP position of the COR. Given the potential that COR can influence the location of contact between the femur and tibia, these findings suggest a mechanism for quadriceps contraction controlling contact location in a manner that could influence progression to OA following ACLR.

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USING AUDITORY FEEDBACK FROM PRESSURE INSOLES TO LOWER MEDIAL KNEE COMPARTMENT LOADS

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Purpose: Knee osteoarthritis (KOA) is a debilitating and progressive joint disease which has a large biomechanical component. Gait alterations are a proven methodology to change the local biomechanics at the knee joint and slow the progression of the disease. While effective, learning a gait modification such as a medial thrust gait can be challenging, time consuming, and an uncomfortable task. Also, decreasing the frontal plane torque at the knee during medial thrust gait often occurs at the expense of increasing other joint moments, specifically the knee flexion moment in the sagittal plane. Here we explore the use of an insole-based feedback device for gait retraining to reduce the peak knee adduction moment (pKAM), a measure of frontal plane torque at the knee and considered a strong biomarker of medial KOA progression. This study compares medial thrust gait with auditory feedback from shoe insoles to medialize plantar pressure. The overall hypothesis of this study is that walking with medialized plantar pressure using feedback will result in a significant reduction in the pKAM and this reduction will be similar to medial thrust gait without increasing the knee flexion moment.

Methods: Healthy subjects underwent a single session of 3-D gait testing. Five normal walking trials were acquired followed by trials 5 trials each of two gait alterations: (1) walking with medial thrust gait and (2) walking while receiving plantar pressure based audible feedback that cued the subjects to medialize plantar pressure. Thus, each subject completed 15 total walking trials and the order which subjects performed the two gait alterations was randomized. For all trials, subjects walked at a self-selected normal speed and only right sided data were analyzed. During the pressure-feedback training, no verbal cues were offered to subjects other than to follow the audible cues while walking. For medial thrust gait, all subjects were trained by a licensed physical therapist. Kinetic and kinematic data were acquired using 28 reflective markers on bony landmarks, 12 optoelectric cameras (Qualysis, Gothenberg, Sweden), and 1 ground-embedded force plate (Bertec, Columbus, OH, USA). A Pedar Insole System (Novel, Munich, Germany) was used to acquire plantar pressure and provide feedback for medialization, a strategy has been based on earlier findings about the relationship of center of pressure location and KAM. All systems were synced and acquired at 100Hz. Paired T-Tests were used for comparisons.

Results: 22 subjects (26.2 yrs ± 3.75 years, 10F,12M) were evaluated. The order which subjects performed the gait alterations had no effect on the change in pKAM ($p>0.33$). Means and SDs of the test results are presented in Table 1. Speed decreased with medial thrust gait ($p<0.001$) and remained unchanged with feedback gait ($p=0.177$). Compared to normal gait, walking with medial thrust gait resulted in a mean pKAM reduction of 0.413 %Bw*Ht ($p<0.001$) and walking with pressure-based feedback resulted in a mean KAM reduction of 0.438 % Bw*Ht ($p<0.001$); these reductions corresponded with a 13.9% and 14.7% pKAM reduction, respectively. Pressure-based feedback resulted in 20 of 23 subjects successfully reducing their pKAM while medial thrust gait resulted in 17 of 23 subjects successfully reducing their pKAM. In contrast, the peak knee flexion moment (pKFM) increased 1.02 %Bw*Ht with medial thrust gait ($p=0.02$) while it remained similar (with a slight decrease on average) for the feedback group ($p=0.34$).

Conclusions: This study demonstrates that medializing plantar pressure is associated with a redistribution of frontal plane loads through the tibiofemoral joint. Feedback from a pressure-detecting insole can be used as a training tool to reduce the pKAM and is as effective as medial thrust gait without increasing sagittal plane loads. Pressure-based feedback may be an effective future treatment modality for subjects with medial compartment knee OA.

Table 1. Peak knee adduction moment, peak knee flexion moment, and speed for each walking condition

	Normal Walk	Medial Thrust Walk	Insole Feedback Walk
Speed(m/s)	**1.47**(0.173)	**1.30**(0.16)	**1.43**(0.20)
Peak Knee Adduction Moment(pKAM) (%Body weight*Height)	**2.97**(0.87)	**2.56**(0.93)	**2.53**(0.87)
Peak Knee Flexion Moment(pKFM) (%Body weight*Height)	**2.91**(1.48)	**3.93**(2.29)	**2.71**(1.26)

*Values are mean (±standard deviation). Bold highlights significant differences compared to Normal ($p<0.05$).

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JOINT BIOMECHANICS AND BONE MATERIAL PROPERTIES RELATIVE TO OA RISK IN WILD MOOSE (*ALCES ALCES*)

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Purpose: Moose in Isle Royale National Park (MI, USA) exhibit the highest known prevalence of osteoarthritis (OA) among wild quadrupeds. Senescence-onset OA in this semi-isolated moose population is dependent on early nutrition. Perinatal malnutrition, indicated by